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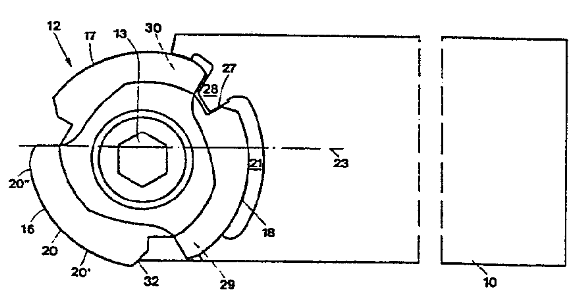
(54) **Cutting insert and cutting tool therefor.**

(57) A cutting insert and a cutting tool for chipforming machining comprising a convex cutting edge (16) which extends along a fraction of the periphery of the one side surface (14) of the insert (12). According to the invention the rear portion (20^1), during machining, of the cutting edge is nearer to the other side suface (15) of the insert (12) than the forward portion (20^{11}), during machining, of the cutting edge.

Fig.2



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Cutting insert and cutting tool therefor

The present invention relates to a cutting insert for chip-forming machining of preferably metallic workpieces. The cutting insert has two side surfaces and is provided with at least one cutting edge having convex shape and extending along a fraction of the periphery of the one side surface. The invention further relates to a cutting tool specifically designed to be used in combination with a cutting insert according to the invention.

A cutting insert and a cutting tool of the above type are described in US-A-4 132 493. For purposes of decreasing the impact load thereon it is suggested to design the cutting edge curved when seen in the longitudinal direction of the cutting tool and from the bottom thereof. Further, due to this design, the forwardmost portion of the cutting edge located adjacent to the longitudinal axis of the tool is prevented from being damaged since the cutting speed at this portion becomes higher than compared to the speed obtained if a straight cutting edge is used. However, it has been found that the forces arising on the cutting insert during the machining have a tendency to cause the insert to be jammed between the supporting surfaces provided on the cutting tool for supporting the insert. This means that difficulties do arise as to the loosening of the insert for the replacing or indexing thereof in order to get a new cutting edge in operative position. It has also been found that high vibrations do arise during machining with solely the rear portion of the cutting edge. This could be avoided by making the entire insert curved and thus also the whole extent of the cutting edge curved from the forwardmost to the rearmost portion thereof. However, such a design involves high manufacturing problems and costs.

The object of the present invention is to provide a cutting insert and a cutting tool being designed such that the insert can be easily loosened. Another object of the invention is to provide a cutting insert being designed such that as small as possible vibrations and as low as possible heat generation do arise thereon during machining and further to ensure satisfactory chip removal. These and other objects have been attained by giving the invention the characterizing features stated in the appending claims.

The invention is described in detail in the following with reference to the accompanying drawings in which one embodiment is shown by way of example. It is to be understood that this embodiment is only illustrative of the invention and that various modifications thereof may be made within the scope of the claims.

In the drawings Fig. 1 shows a side view of a cutting insert and a cutting tool according to the invention.

Fig. 2 shows a side view of the cutting insert and the cutting tool seen from the left in Fig. 1.

Fig. 3 shows a plan view of the cutting insert in Figs. 1 and 2.

Fig. 4 is a partial side view of the insert in Fig. 3 seen on the line IV-IV.

Fig. 5 is a partial side view of the insert in Fig. 3 seen on the line V-V.

Fig. 6 shows a section through the insert in Fig. 3 taken on the line VI-VI.

Fig. 7 shows a partial section through the insert in Fig. 3 taken on line VII-VII.

In the drawings, Figs. 1 and 2 show an end mill body 10 having a ball-shaped end 11, to which a cutting insert 12 in a manner known per se is secured by means of a fastener 13. The cutting insert 12, which preferably is made of cemented carbide, is designed for chipforming machining of metallic workpieces. The cutting insert 12 is triangular and provided with two side surfaces 14, 15. There are three equally shaped cutting edges 16, 17, 18 along the periphery of the side surface 14 equally spaced therearound. The cutting edges 16, 17, 18 comprise a convex portion 20 having the convexity directed generally in the plane of the side surface 14 and are bent toward the side surface 15 at their forwardmost portion 19, thereby defining the cutting edges by a spiral curved line. In US-A-4 132 493 there is disclosed an end mill and a cutting insert, the cutting edge of which having basically the same shape as the cutting edges 16, 17, 18. Therefore, US-A-4 132 493 is incorporated in the present description by way of reference. However, contrary to the design shown in US-A-4 132 493, both the portion 20 and the portion 19 are curved along circle arcs. The tool body 10 is rotatable around its longitudinal axis 23. In the cutting end of the tool body 10 there is provided a recess 21 in which the cutting insert 12 is clamped against a supporting surface 22 by means of the fastener 13. In the clamped position the operative cutting edge 16 of the insert 12 projects beyond the tool body.

Intermediate peripheral spaces 24, 25, 26 are provided in the cutting insert 12 between two consecutive cutting edges 16, 17, 18. At the one side these spaces are limited by a supporting surface 27 provided at the rear end of the adjacent cutting edge. An abutment 28 is provided on the tool body 10 in the space 25 which is diametrically opposed to the operative cutting edge 16. The abutment 28 cooperates with the supporting surface 27 so as to prevent rotation of the insert 12 around the axis of the fastener 13.

The cooperating supporting surfaces, i.e. the supporting surface 27 and the corresponding supporting surface on the abutment 28, are directed substantially towards the centre of the fastener 13. This means that no radial relative movement might arise along these supporting surfaces. Thus, there is no risk that the insert 12 becomes jammed. When the insert 12 is to be replaced or indexed the fastener 13 can be easily loosened. There are provided another two supporting surfaces on the tool body 10 intended to cooperate with surfaces 29, 30 on the insert 12 in order to further ensure that the insert is maintained in correct angular position and prevent rotation of the insert.

According to the invention a recess 31 is provided in the side surface 14 in connection with the cutting edge 16 in such a way that the rear portion 20^{1} of the cutting edge 16 is nearer to the side surface 15 than the forward portion 20^{11} thereof. The portion 20^{1} is located rearwardly of the portion 20^{11} during machining. Due to this design it is ensured that the different portions of the cutting edge come into contact with the workpiece sequentially after each other, more precisely in such a way that the forward portion 20^{11} of the cutting edge 16, wholly or partially, has finished its cutting operation before the rear portion 20^{1} of the cutting edge comes into contact with the workpiece. Due to this, no or minor vibrations will arise which would be the case, especially during cutting with solely the radially outer portion of the cutting edge, if the entire cutting edge was lying in the plane of the side surface 14. In the preferred embodiment the cutting edge 16 progressively approaches the side surface 15 along the rear portion 20^{1}. The portion 19 which is bent toward the side surface 15, and thus the operative cutting edge, starts in the vicinity of the longitudinal axis 23 of the tool body. As above-mentioned the varying distance of the cutting edge 16 from the side surface 15 in the longitudinal direction of the tool body 10 is created by means of the recess 31 in the side surface 14.

The recess 31, acting as a chip breaker, extends along both the portion 20^{1} and the portion 20^{11}. In the preferred embodiment the recess 31 continues, wholly or partially, along the portion 19.

For purposes of producing as small as possible vibrations and as low as possible heat generation the insert is, according to the invention, provided with a comparatively large positive rake angle γ at its rear portion 20^{1}. According to the invention, further, the rake angle γ is positive and still larger at the forward portion 20^{11} than at the rear portion 20^{1}. Preferably, the rake angles γ^{11} and γ^{1}, respectively, are in respectively the order of 18^{o} and 7^{o}. In an intermediate portion of the cutting edge the rake angle γ^{111} has a value between 7^{o} and 18^{o}. Due to the fact that the supporting surface 22 is inclined with respect to the longitudinal axis 23 the rake angles, when the cutting insert is mounted thereon, are larger, in the order of respectively 26^{o} and 15^{o}. The reason why the rake angle is larger at the forward portion 20^{11} than at the rear portion 20^{1} is that the forward portion of the cutting edge can be said to work as a drill and that the optimal rake angle is larger for a drill than for a milling cutter.

In the preferred embodiment an auxiliary cutting edge 32 is provided at the rear end of the cutting edge 16. The cutting edge 32, which extends transversely relative to the cutting edge 16 and forms an obtuse angle therewith, is intended to cut the workpiece during reversed relative movement between the insert 16 and the workpiece.

In the illustrated embodiment the cutting insert is provided with three cutting edges. However, the invention, as to the shape of the cutting edge, might as well be applied on an invert having an arbitrary, for instance two, number of cutting edges.

When mounting an insert having two cutting edges on the tool body the insert is fixed against a first supporting surface which rests against a transverse surface at the rear end of the operative cutting edge, and against a second supporting surface which rests against a portion of the insert at the forward part of the non-operative cutting edge.

Claims

1. A cutting insert for chipforming machining of preferably metallic workpieces, said insert (12) having two side surfaces (14, 15) and at least one cutting edge (16), said cutting edge being convex and extending along a fraction of the periphery of the one side surface (14), wherein the convexity is directed generally in the plane of said one side surface, c h a r a c t e r i z e d in that a recess (31) is provided in said one side surface adjacent to the cutting edge (16) in such a way that the rear portion (20^{1}), during the machining, of the cutting edge (16) is nearer to the other side surface (15) than a forward portion (20^{11}), during the machining, of the cutting edge (16).

2. Cutting insert according to claim 1, wherein the cutting edge (16), along at least a fraction of its length, preferably along the said rear portion (20^{1}) thereof, progressively approaches the said other side surface (15).

3. Cutting insert according to claim 1 or 2, wherein the cutting insert (12) is provided with a positive rake angle (γ) which is larger at the said forward portion (20^{11}) than at the said rear portion (20^{1}), preferably in the order of 18^{o} and 7^{o}, respectively.

4. A cutting insert according to any of the preceding claims, wherein the forwardmost portion of the cutting edge (16) is bent toward the said other side surface (15), thereby providing a spiral curved cutting edge.

5. A cutting insert according to claim 4, wherein the recess (31), working as a chip breaker, at least partly, extends along the said forwardmost portion (19) of the cutting edge (16).

6. A cutting insert according to any of the preceding claims, wherein the cutting insert (12) is triangular and provided with three equally shaped cutting edges (16, 17, 18).

7. A cutting insert according to claim 6, wherein a second cutting edge (32) is provided at the rear end of the convex cutting edge (16), said second cutting edge extending transversely relative to the convex cutting edge (16), preferably under an obtuse angle therewith and being adapted to make possible machining of the workpiece upon a reversed relative motion between the cutting insert (12) and the workpiece.

8. A cutting insert according to claim 6 or 7, wherein a peripheral space (25) is provided between two consecutive cutting edges (17, 18), said space being bound by a supporting surface (27) on the cutting insert at the rear end of the convex cutting edge (18), said supporting surface being intended to cooperate with an abutment (28) on an insert-carrying tool body (10) for fixing the cutting insert (12), and said supporting surface being directed substantially toward the centre of the cutting insert (12).

9. A cutting tool for chipforming machining of preferably metallic workpieces comprising a tool body (10) rotatable around an axis (23) extending longitudinally therethrough, a cutting end of said tool body having at least one recess (21) for receiving a cutting insert (12) of the type defined in claim 1, wherein the operative cutting edge (16) of said cutting insert projects beyond the profile of said cutting end and comprises a convex portion (20) which extends in the direction of said longitudinal axis (23), said convex cutting edge portion (20) being provided along a fraction of the periphery of one side surface (14) of the cutting insert, the convexity being directed generally in the plane of said one side surface, and wherein the other side surface (15) is adapted to be clamped against a supporting surface (22)

in the tool body (10), c h a r a c t e r i z e d in that a recess (31) is provided in such a way in said one side surface adjacent to the cutting edge (16) that the rear portion (20^1), during the machining, of the cutting edge (16) is nearer to said supporting surface (22) than a forward portion (20^{11}), during the machining, of the cutting edge (16), wherein preferably the cutting insert (12) is triangular and provided with three equally shaped cutting edges (16, 17, 18), a peripheral intermediate space (25) is provided between two consecutive cutting edges (17, 18), and said cutting edges preferably are bent toward the supporting surface (22) at their forwardmost portions (19) and start in the vicinity of said longitudinal axis (23), and further characterized in that an abutment (28) is provided on the tool body (10) for cooperation with a supporting surface (27) in one of said intermediate spaces, said abutment being diametrically opposed to the operative cutting edge (16).

10. A cutting tool according to claim 9, wherein the surface of the abutment (28) intended to cooperate with the supporting surface (27) of the cutting insert (12) is directed substantially toward the centre of the cutting insert (12).

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Fig.1

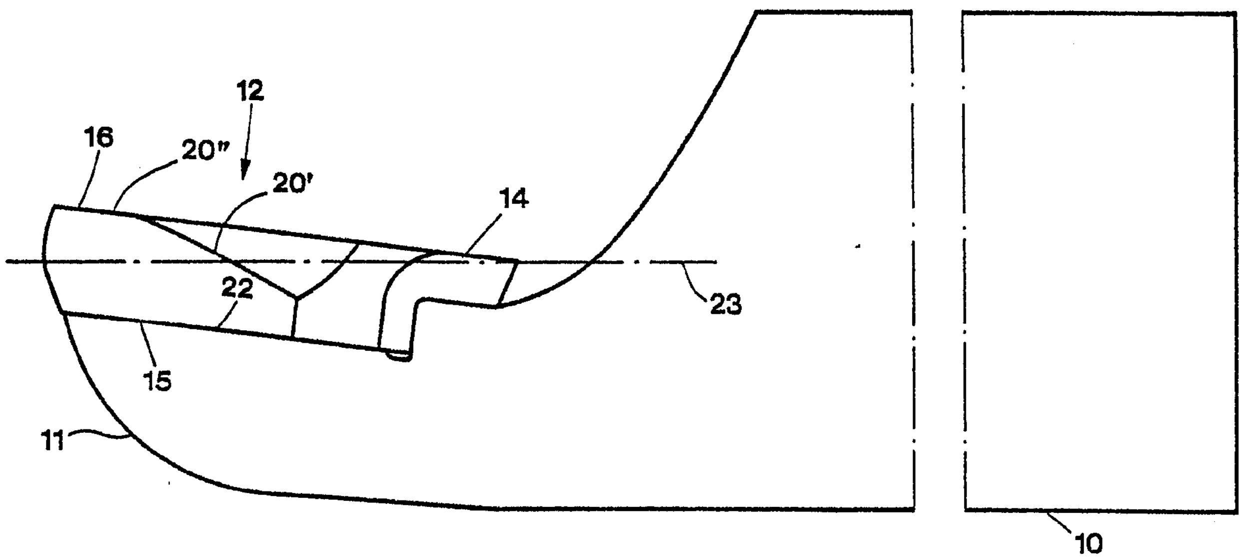

Fig.2

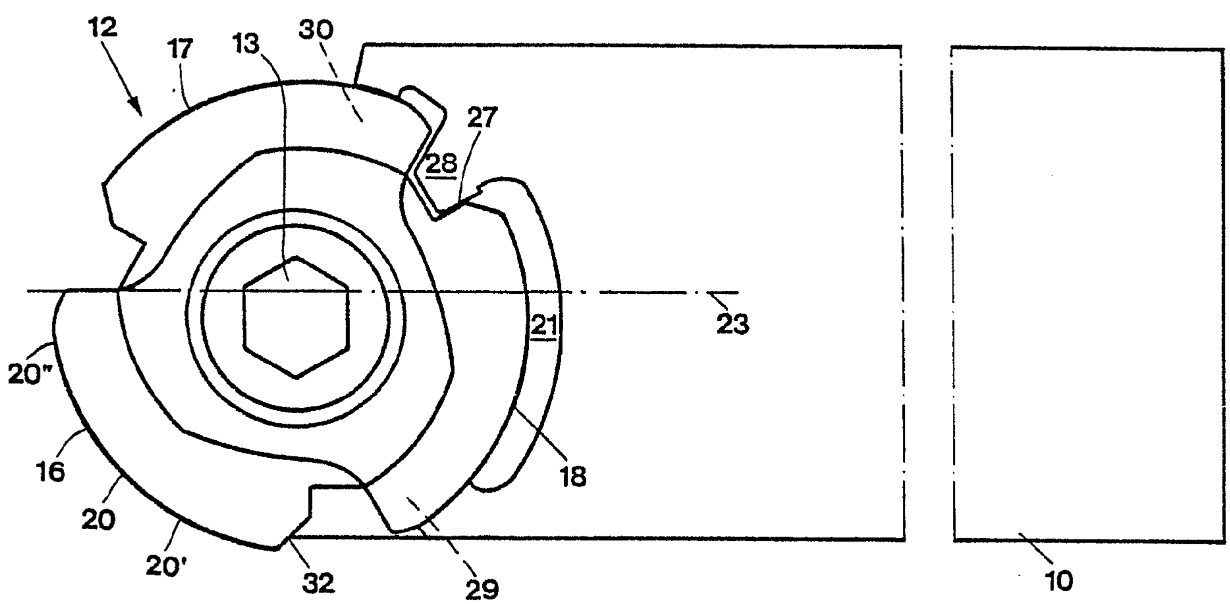

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Fig.3

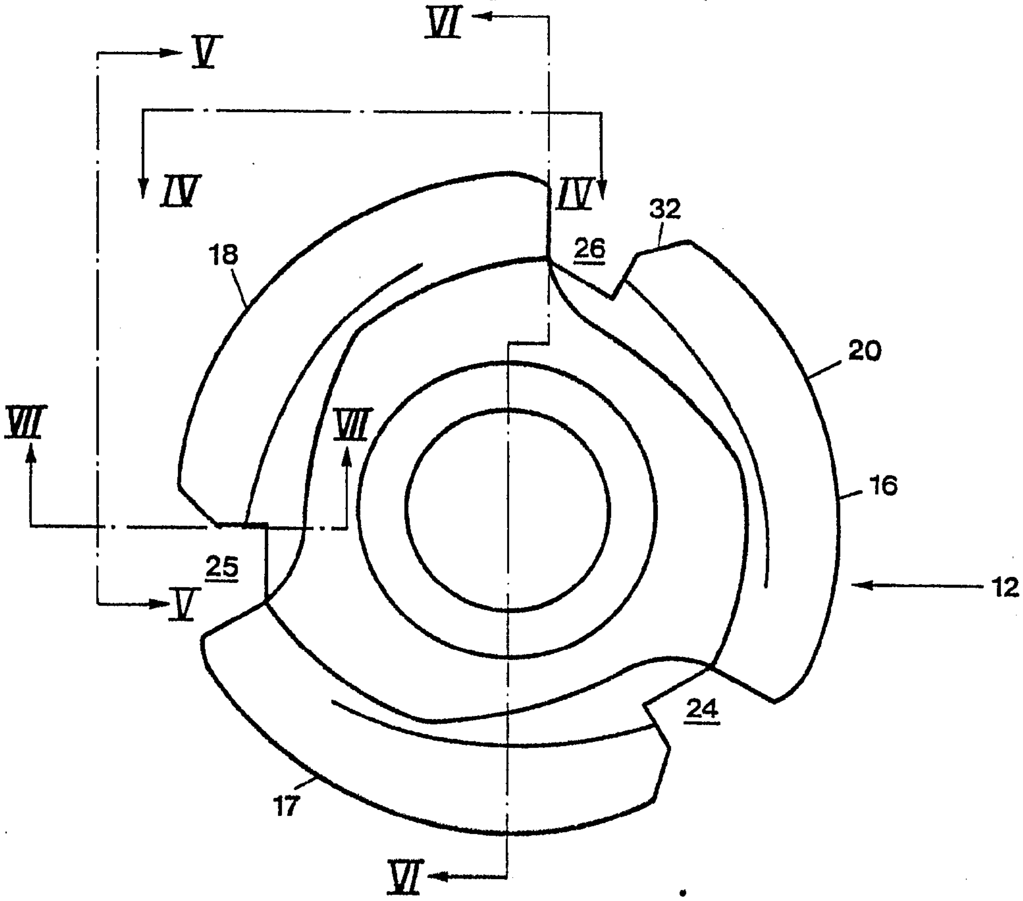

Fig.4

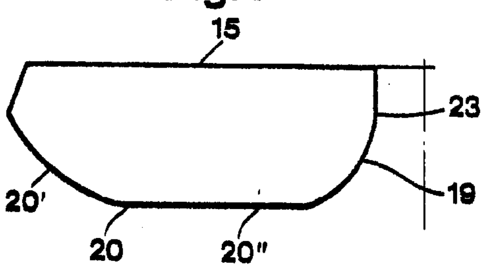

Fig.5

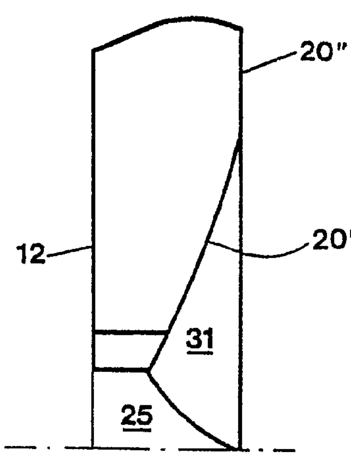

Fig.6

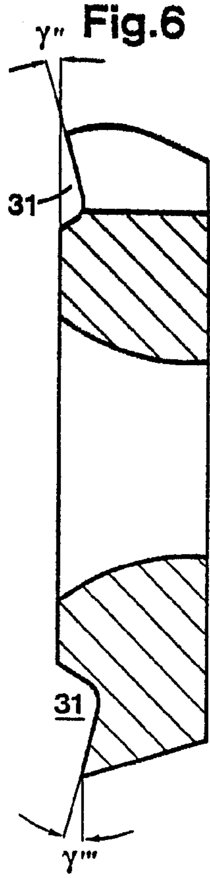

Fig.7